*भारतीय मानक*

***Indian Standard***

**IS 8647 : 2023**

# वायुचालित वाहक पद्धतियों के डिजाइन के लिए मानदंड

*( पहला पुनरीक्षण )*

# Design Criteria for Pneumatic Conveying Systems

*( First Revision )*

ICS 53.040



भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुर शाह ज़फर मार्ग, नई दिल्ली-110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI - 110002
www.bis.gov.inwww.standardsbis.in

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Earth Moving Equipment and Material Handling Sectional Committee, MED 07

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Earth Moving Equipment and Material Handling Sectional Committee had been approved by the Mechanical Engineering Division Council.

This Indian Standard will supersede IS 8647 : 1977.

Pneumatic conveying systems are basically quite simple and are eminently suitable for the transport of powdered and granular materials in factory, site and plant situations. The system requirements are a source of compressed gas, usually air, a feed device, a conveying pipeline and a receiver to disengage the conveyed material and carrier gas.

The system is totally enclosed, and if it is required, the system can operate entirely without moving parts coming into contact with the conveyed material. High, low or negative pressures can be used to convey materials. For hygroscopic materials dry air can be used, and for potentially explosive materials an inert gas such as nitrogen can be employed. A particular advantage is that materials can be fed into reception vessels maintained at a high pressure if required.

The composition of the committee responsible for the formulation of this standard is listed in Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# DESIGN CRITERIA FOR PNEUMATIC CONVEYING SYSTEMS

*( First Revision )*

## 1 SCOPE

This standard lays down the design criteria for low, medium and high pressure pneumatic conveying systems.

## 2 TERMINOLOGY

Pneumatic conveying is defined as the art of transporting dry bulk materials through a pipeline by using either a negative or a positive pressure air stream.

## 3 LIMITATIONS

The principal limiting factor in the use of pneumatic conveyors is usually the material to be conveyed, Materials to be conveyed should be dry and relatively free-flowing.

**3.1** Friable materials as a rule should not be conveyed pneumatically, except when partial degradation of the material being conveyed is inconsequential to end use of the material.

**3.2** Without booster stations, vacuum systems are practical up to 500 m in length and pressure systems up to 2 km or more.

## 4 TYPES

**4.1** The following are the main conveying systems:

a) Low Pressure System;
   1) Positive pressure system;
   2) Negative pressure system; and
   3) Combined negative-positive pressure system;
b) Medium Pressure System; and
c) High Pressure System.

### 4.2 Low Pressure System

Low pressure systems are ideal for inplant use to convey non-abrasive mildly-abrasive or dry pulverized materials. Air pressure used in normally limited to 760 mmHg (1 atmosphere), and the air supply is provided by a positive displacement lobe type of blower, because of the low pressure. These systems are restricted to a relatively short distance and small flow rate.

**4.2.1** Positive pressure system is normally used for conveying material form one source to several remotely located discharge points. A typical positive pressure system is illustrated in Fig. 1.

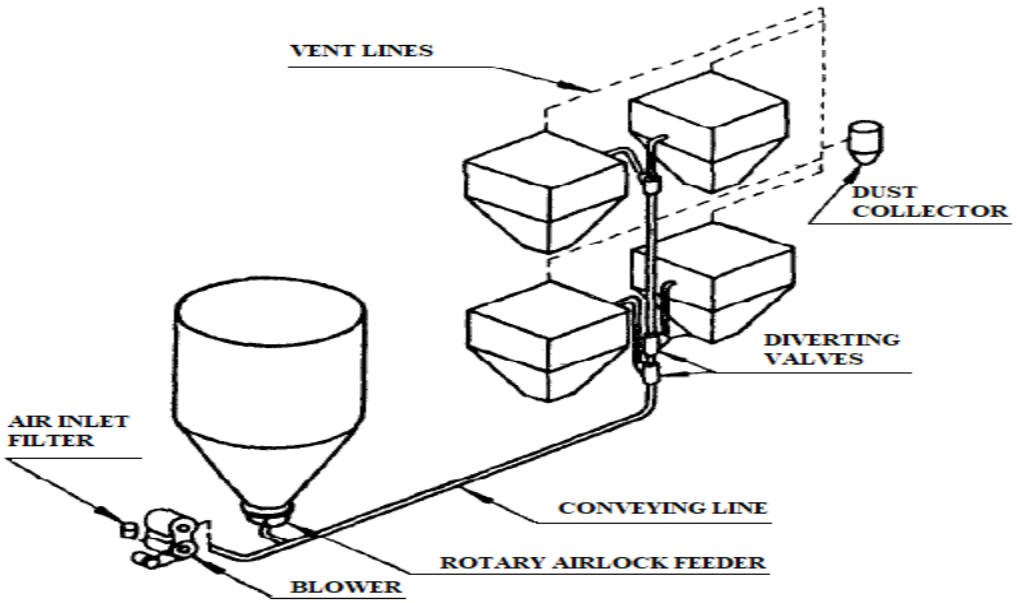


FIG. 1 POSITIVE PRESSURE SYSTEM

**4.2.2** Negative pressure system is normally used for conveying material from several sources to and remotely located discharge point. A typical negative pressure system is illustrated in Fig. 2

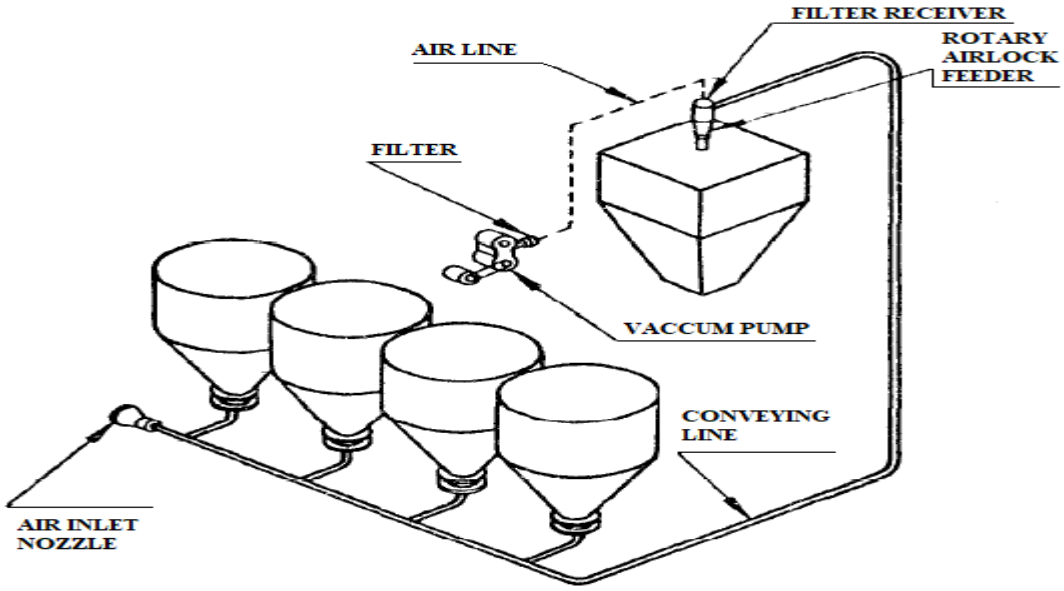


FIG. 2 NEGATIVE PRESSURE SYSTEM

**4.2.3** A combined negative-positive pressure system is generally used for conveying materials from several sources to several discharge points. This type of system is quite versatile and is commonly used for conveying materials from railway container wagons and/or storage bins to different points of use. A typical negative-positive pressure system is illustrated in Fig. 3.

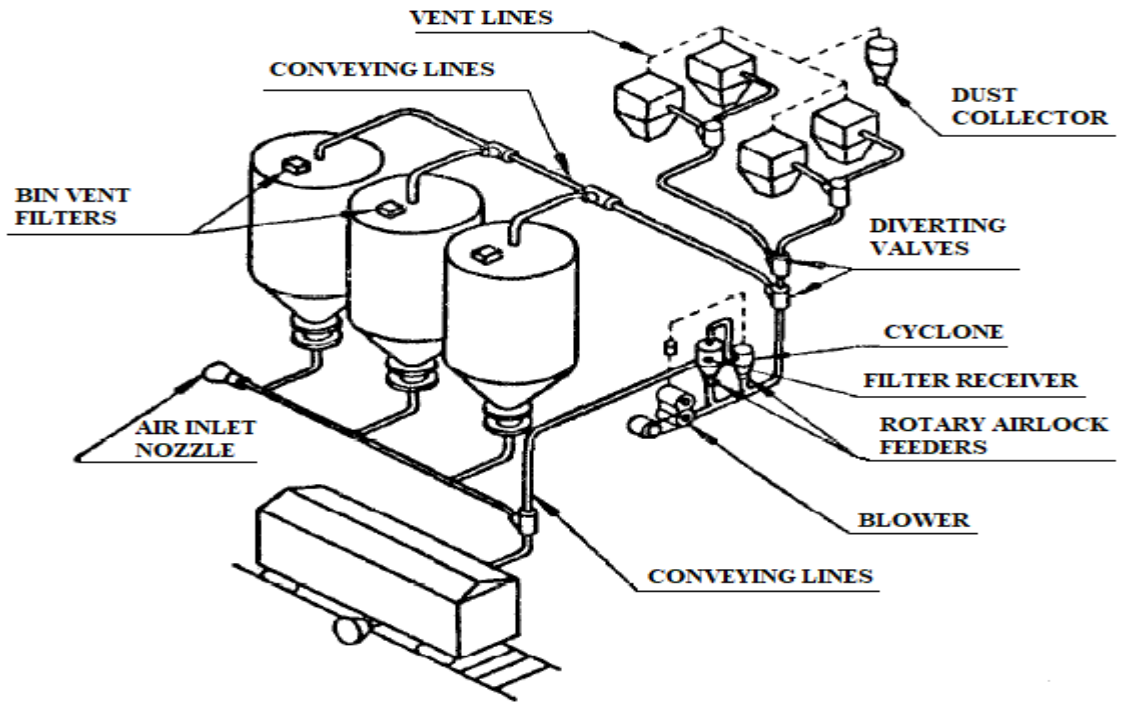


FIG. 3 NEGATIVE POSITIVE PRESSURE SYSTEM

### 4.3 Medium Pressure System

In medium pressure system, the material is first compacted in a variable pitch screw before it is mixed with compressed air in the mixing chamber of the screw type pump. This system thus requires a screw directly couple with motor in addition to a compressor for providing air at pressure ranging between 760 mmHg to 280 mmHg (1 to 3 atmospheres). Air pressure which can be used in this system is limited because of the necessity of providing a seal between the screw and the mixing chamber. This type of pump conveys continuously. A single stage rotary compressor is generally connected directly with the screw type pump for supplying the required compressed air.

### 4.4 High Pressure System

High pressure system uses dense steam conveying with low ratio of air to material resulting in lowest particle degradation when handling friable materials. Because of higher air pressure used, smaller pipelines can be used in this system.

**4.4.1** High pressure conveying pumps are batch type units which use compressed air only when conveying. These pumps are used for continuous, intermittent or batching operations. In a continuous process operation, a surge hopper is provided above the pump for collecting the material during the discharge cycle of the pump. A typical high pressure system is illustrated in Fig. 4.

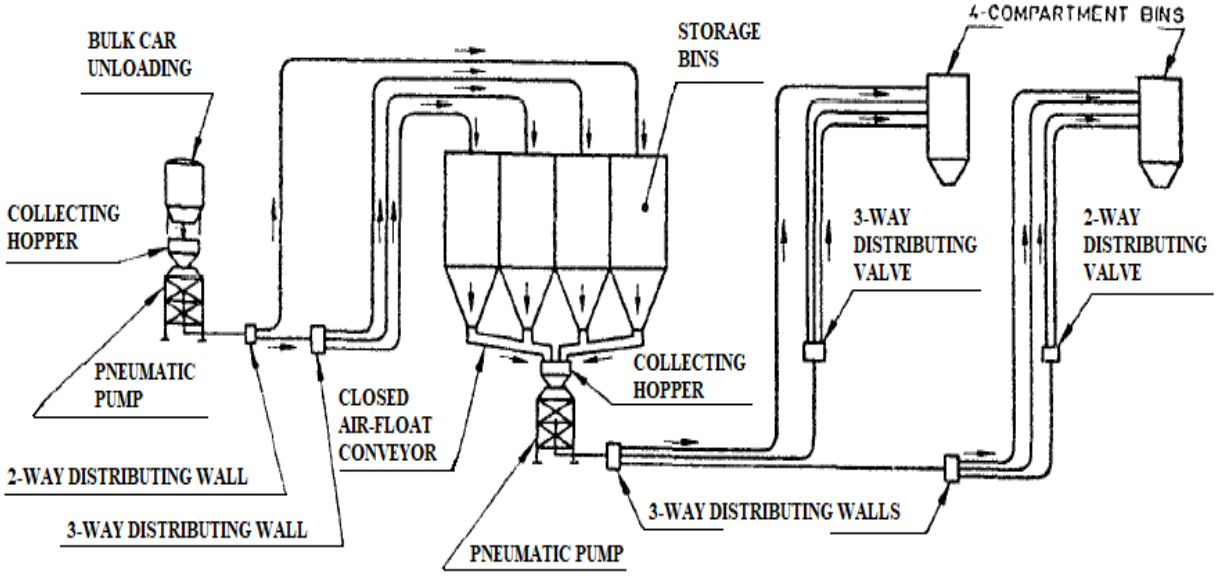


FIG. 4 HIGH PRESSURE SYSTEM

**4.4.2** For high pressure conveying system a double stage compressor is normally used for supplying compressed air at pressures ranging between 3 040 mmHg to 5 320 mmHg (4 to 7 atmospheres). Pumping being a batch operation, an air receiver is required for the compressed air. The air receiver should be sized in such a way that full pressure in the air receiver is recovered in the time the pump performs the filling and discharging operation. The compressor delivers air continuously during the discharge cycle and should be completed by the time the pump is filled again with material.

## 5 FACTORS FOR DESIGN AND USE

**5.1** The material to be conveyed should be known by all its characteristics including bulk density, particle size and shape, temperature, susceptibility to moisture, corrosiveness, nature of material, abrasiveness and moisture.

### 5.2 Bulk Density

The mass per unit volume should be known under three conditions, namely, in poured condition, stored in bin and when under influence of aeration. The material may enter the system in the poured state, but when it is discharged, it may be in the aerated state, which means that more bulk is involved at the discharge than at the entrance. Volumetric capacity, as well as flow ability is vitally effected by this phenomenon.

### 5.3. Particle Size

The particle size of material to be classified as below:

| | |
|---|---|
| Very fine | All passing 150-micron sieve |
| Fine | All passing 1.00 mm sieve |
| Granular | All passing 12.50 mm sieve |
| Lumpy and irregular | More than 12 mm in any direction. Irregular materials are those that are fibrous, stringy, etc. |

### 5.4 Moisture Content

The moisture content of material should be known. The conveying rate of material reduces with increase in moisture. For satisfactory operation, free moisture should normally not exceed 1 percent by mass.

### 5.5 Corrosiveness

The *p*H (a symbol denoting acidity on alkalinity) value of material should be known. This information is necessary for selecting the material of construction for conveying equipment and also the type of cloth to be used in dust collector. A highly corrosive material may require special materials of construction.

### 5.6 Explosive or Combustible Nature of Material

Even though pneumatic conveying is amongst the safest material handling techniques. However in handling explosive or combustible materials, precautions in the system must be taken. Some of these materials may require inert gas to be used as conveying medium.

### 5.7 Abrasiveness

Abrasiveness may be classified as follows:

| *Sl No.* (1) | *Class* (2) | *Abrasiveness* (3) |
|---|---|---|
| i) | 1 | Non-abrasive |
| ii) | 2 | Slightly abrasive |
| iii) | 3 | Medium abrasive |
| iv) | 4 | Highly abrasive |

Materials having hardness above that of 'highly abrasive' materials are mostly too abrasive to be handling in pneumatic conveyors.

### 5.8 Duty Requirement

In conjunction with conveying rates, the severity of operation should also be determined. The construction of pneumatic conveyor can be linked to the degree of design and construction of speed reducer. Severity of operation can be classified as follows:

| *Sl No.* | *Class* | *Hours of Operation Per Week* |
|---|---|---|
| (1) | (2) | (3) |
| i) | 1 | 160 |
| ii) | 2 | 80 |
| iii) | 3 | 40 |
| iv) | 4 | 20 |

With the above classification, the degree of sturdiness to which the conveyor must be constructed, can be determined. It will also tell the appurtenances necessary to meet the requirements of the operation.

### 5.9 Elevation and Environmental Condition

a) Elevation of the installation in relation to sea level should be known. Difference in air density is very pronounced in the operation of pneumatic conveyors and should always be considered; and
b) Environmental condition, that is, whether system is exposed to hazardous dusts and gases or corrosive elements should be known.

## 6 DESIGN PROCEDURE

Based on the factors mentioned above, the Tables 1, 2 and 3 may be used for determining the type of conveying to be used.

**Table 1 System Type According to Particle Size**

| Sl No. | Particle Size | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| i) | Lumpy or irregular | × | × | × | – | – |
| ii) | Granular | × | × | × | – | × |
| iii) | Fine | × | × | – | – | × |
| iv) | Very fine | × | × | × | × | × |

NOTE — × indicates suitability.

**Table 2 System Type According to Material Characteristics**

| Sl No. | Material Characteristic | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| i) | Non-abrasive | × | × | × | × | × |
| ii) | Abrasive, slightly | × | × | × | × | × |
| iii) | Abrasive, medium | * | * | – | × | × |
| iv) | Abrasive, high | – | – | – | × | × |
| v) | Hygroscopic | × | × | – | – | – |
| vi) | Deliquescent | * | * | * | * | * |
| vii) | Combustible | × | × | × | × | – |
| viii) | Explosive | × | × | × | – | – |
| ix) | Acid | × | × | × | × | × |
| x) | Alkaline | × | × | × | × | × |
| xi) | Toxic | – | – | – | – | – |
| xii) | Fragile | × | × | – | – | – |
| xiii) | Corrosive | * | * | * | * | * |
| xiv) | Thermoplastic | × | × | – | – | – |

NOTES

**1** × Indicates suitability.

**2** * Indicates that a pilot study will be necessary to establish the suitability of the material for pneumatic conveying. Arrangements are being made to conduct such study.

**Table 3 System Type According to Material**

| Sl No. | Material | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| i) | Alum | × | × | – | – | – |
| ii) | Alumina, floury | × | – | × | × | – |
| iii) | Alumina, sandy | × | – | – | × | – |
| iv) | Aluminium hydrate | × | – | – | × | × |
| v) | Aluminium oxide | – | × | – | – | – |
| vi) | Arsenic oxide | × | – | – | – | – |
| vii) | Asbestos dust | × | – | – | – | – |
| viii) | Barites | – | – | – | × | – |
| ix) | Bauxite | × | – | – | × | – |
| x) | Best pulp, dried | × | – | – | – | – |
| xi) | Bentonite | × | × | × | × | × |
| xii) | Borax | × | × | – | × | × |
| xiii) | Calcium carbonate | × | × | × | × | – |
| xiv) | Calcium phosphate | – | – | – | × | – |
| xv) | Carbon, activated | × | × | × | × | – |
| xvi) | Carbon black, pelletized | * | * | – | – | – |
| xvii) | Catalysts, petroleum | × | – | – | × | – |
| xviii) | Cellulose acetate | × | × | – | – | – |
| xix) | Cement, portland | – | – | – | × | × |
| xx) | Cement, raw materials | – | – | – | × | – |
| xxi) | Cereals | × | × | – | – | – |

**Table 3** (*Continued*)

| Sl No. | Material | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| xxii) | Cerelose | × | × | – | – | – |
| xxiii) | Clay, kaolin | × | × | – | × | – |
| xxiv) | Coal, pulverized | – | – | – | × | × |
| xxv) | Coffee beans | × | × | – | – | × |
| xxvi) | Coke, fines and flour | × | × | – | – | – |
| xxvii) | Corn grits | × | × | – | – | – |
| xxviii) | Cottonseed meal | × | × | – | – | – |
| xxix) | Detergent powders | × | × | – | × | – |
| xxx) | Diatomaceous earth | × | × | × | × | – |
| xxxi) | Dolomite | – | – | – | × | × |
| xxxii) | Feed ingredients | × | × | – | – | – |
| xxxiii) | Feeds, soft | × | × | – | – | – |
| xxxiv) | Feldspar | × | – | – | × | – |
| xxxv) | Fertilizers | * | * | – | * | * |
| xxxvi) | Flaxseed | × | × | – | – | – |
| xxxvii) | Flint | – | – | – | × | × |
| xxxviii) | Flour, wheat | × | × | – | – | – |
| xxxix) | Fluorspar | – | – | – | × | – |
| xl) | Fly ash | – | – | – | × | – |
| xli) | Fuller’s earth | × | × | – | × | – |
| xlii) | Gluten meal | × | × | – | – | – |
| xliii) | Grain whole | × | × | – | – | – |

**Table 3** (*Continued*)

| Sl No. | Material | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| xliv) | Grain, ground | × | × | – | – | – |
| xlv) | Graphite | × | × | – | – | – |
| xlvi) | Gypsum | × | × | – | × | – |
| xlvii) | Lime, hydrated | × | × | × | × | × |
| xlviii) | Lime, pebble | × | × | – | – | – |
| xlix) | Limestone, pulverized | – | – | – | × | – |
| l) | Magnesium oxide | × | × | – | × | – |
| li) | Malt, brewers | × | × | – | – | – |
| lii) | Milk, dried | × | × | – | – | – |
| liii) | Ores, pulverized | – | – | – | × | × |
| liv) | Petroleum coke | × | × | – | – | – |
| lv) | Phosphate rock, pulverized | – | – | – | × | × |
| lvi) | Polyethylene | × | × | × | – | – |
| lvii) | Pyrites | – | – | – | × | × |
| lviii) | Resins | × | × | × | – | – |
| lix) | Rice | × | × | – | – | – |
| lx) | Rubber pellets | × | × | – | – | – |
| lxi) | Salt | × | × | – | – | – |
| lxii) | Salt cake | × | × | – | – | – |
| lxiii) | Sawdust | × | × | × | – | – |
| lxiv) | Seeds | × | × | – | – | – |
| lxv) | Semolina (*Suji*) | × | × | – | – | – |

**Table 3** (*Concluded*)

| Sl No. | Material | Type of System | | | | |
|---|---|---|---|---|---|---|
| | | Low Pressure | | | Medium Pressure | High Pressure |
| | | Negative | Positive | Negative-Positive | | |
| (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| lxvi) | Silica, pulverized | – | – | × | – | – |
| lxvii) | Soap ingredients | × | × | – | * | – |
| lxviii) | Soda ash, light | × | × | × | – | – |
| lxix) | Soda ash. dense | * | * | – | – | – |
| lxx) | Sodium carbonate | × | × | – | – | – |
| lxxi) | Sodium phosphates | × | × | – | × | – |
| lxxii) | Sodium sulphate | × | × | – | – | – |
| lxxiii) | Starch | × | × | × | × | – |
| lxxiv) | Sugar, granulated | × | × | – | – | × |
| lxxv) | Talc | × | × | × | × | – |
| lxxvi) | Titanium dioxide | * | * | – | – | – |
| lxxvii) | Wood chips | – | × | – | – | – |
| lxxviii) | Wood flour | × | × | – | – | – |
| lxxix) | Zinc oxide | × | × | – | × | – |

NOTES

**1** × Indicates suitability.

**2** * Indicates that a pilot study will be necessary to establish the suitability of the material for pneumatic conveying. Arrangements are being made to conduct such study.

**ANNEX A**
(*Foreword*)

**COMMITTEE COMPOSITION**

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## Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
|---|---|---|
| | | |
| | | |
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**BUREAU OF INDIAN STANDARDS**

**Headquarters:**

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
*Telephones*: 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.gov.in

| **Regional Offices:** | | *Telephones* |
|---|---|---|
| Central | : 601/A, Konnectus Tower -1, 6th Floor, DMRC Building, Bhavbhuti Marg, New Delhi 110002 | 2323 7617 |
| Eastern | : 8th Floor, Plot No 7/7 & 7/8, CP Block, Sector V, Salt Lake, Kolkata, West Bengal 700091 | 2367 0012<br>2320 9474 |
| Northern | : Plot No. 4-A, Sector 27-B, Madhya Marg, Chandigarh 160019 | 265 9930 |
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| Western | : Plot No. E-9, Road No.-8, MIDC, Andheri (East), Mumbai 400093 | 2821 8093 |

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